

## SAFETY NOTE 16 A NUMERICAL ALGORITHM FOR ESTIMATING CHEMICAL EXPOSURE HAZARDS

by  
Tim Miller  
August 1988

### Introduction

Chemical exposures are ideally assessed by comparing monitoring results with exposure limits. Unfortunately, such monitoring is not always carried out because of the limited availability of industrial hygiene expertise, to say nothing of time and expense.

Symbol	Variable	Dermal	Gas	Solid	Vapor	Unit
AW	Wetted surface area				<b>X</b>	ft <sup>2</sup>
FA	Atmospheric exposure			<b>X</b>		-
FO	Dermal exposure factor	<b>X</b>				-
P	Annual number of procedures		<b>X</b>			yr-1
NT	Cumulative annual exposure duration	<b>X</b>	<b>X</b>	<b>X</b>		person-year
QR	Room ventilation		<b>X</b>		<b>X</b>	cfm
SKN	Skin hazard index	<b>X</b>				-
TL	Liquid temperature				<b>X</b>	°F
TWA	Exposure limit		<b>X</b>	<b>X</b>	<b>X</b>	ppm or mg/m <sup>3</sup>
VG	Gas volume		<b>X</b>			ft <sup>3</sup>
VP	Vapor pressure		<b>X</b>			mmHg
VR	Room value		<b>X</b>			ft <sup>3</sup>

### Atmospheric Hazard Index

- Gases  

$$AHIG = \log (250 \text{ ppm/TWA}) + \log (100 \text{ cfm/QR}) + \log (VG/VR/2.5 \times 10^{-4}) + \log (NP)$$
- Solids (includes mists)  

$$AHIS = \log (2.5 \text{ mg per m}^3/\text{TWA}) + \log (NT) + FA$$
- Vapors (includes gases dissolved in liquids)  

$$AHIV = \log (250 \text{ ppm/TWA}) + \log (NT) + \log (100 \text{ cfm/QR}) + \log (VP/100 \text{ mmHg}) +$$

$$\log (AW) + (T - 70^{\circ}\text{F}) / 60^{\circ}\text{F}$$

### Dermal Hazard Index

$$\text{DHI} = \text{SKN} + \log (\text{NT}) + \text{FD}$$

### Definitions

AW (ft<sup>2</sup>) - The effective wetted surface area exposed to the atmosphere. When liquids are applied to surfaces, the effective area will generally be less than the total area being treated due to evaporative losses.

FA (dimensionless) - The atmospheric exposure factor is a logarithmic estimate of the particulate concentration based on the type of operation and observed releases.

#### FA INDICATION

---

+1	General visibility reduced near operation.
0	Visible emissions near worker breathing zone.
-1	Operation near worker breathing zone which can be expected to produce emissions, but none visible
-1	Visible emissions distant from worker breathing zone.
-2	Operation distant from worker breathing zone which can be expected to produce emissions, but none visible.
-2	Incidental worker activities resuspend settled particulates.
-2	Stirring liquids.

FD (dimensionless) - The dermal exposure factor is a quantitative estimate of the intensity of dermal exposure based on the type of operation and apparent contact.

#### FD INDICATION

---

+2	Frequent direct contact. Prolonged wetting/covering of skin.
+2	Infrequent/accidental direct contact. Brief wetting/covering of skin.
0	No direct contact. No wetting/covering of skin.

NP (yr-1) - The annual number of procedures is equal to the number of days in a year in which an individual disturbs a pressurized gas system for the purpose of adjustment, repair or replacement. If two people disturb a system on the same day, it counts as two procedures.

NT (person-day/yr) - The cumulative annual exposure duration is the product of the number of people and number of days which they are actually exposed to the materials in a year for the operation of interest. Time periods used to calculate NT should use appropriate fractions of 8 hr days.

QR (cfm) - The room ventilation is an estimate of dilution ventilation for the space housing

the operation of interest. Most buildings may be assumed to have 1-2 volume changes per hour, except offices which may be assumed to have 6. If better information is available on ventilation, it should be used.

SKN (dimensionless) - The skin hazard index is an estimate of the overall dermal hazard of a material, exclusive of handling factors. It is calculated from the Fermilab hazard rating system according to the following expression and can be found on the procedures printout.

$$SKN = DER2 + COR2 + SNS2 - 2$$

TL ( $^{\circ}$ F) - The temperature of the evaporating liquid. The temperature correction factor should only be used for the TL  $>$ ,  $70^{\circ}$ F, at lower temperatures the vapor pressure will be underestimated.

TWA (ppm or  $\text{mg}/\text{m}^3$ ) - The occupational time weighted average exposure limit for the material as listed in the current edition of ACGIH TLV booklet. Parts per million (ppm) apply to gases and vapors while  $\text{mg}/\text{m}^3$  applies to particulates. For materials which have no TWA listed, it can be estimated from the Toxicity rating table.

VG ( $\text{ft}^3$ ) - The total NTP volume of gas which can be released as the result of an accident.

VP (mmHg) - The vapor pressure of the material at room temperature ( $\sim 70^{\circ}$ F or  $21^{\circ}$ C). This applies to gases dissolved in liquids as well as evaporating materials.

VR ( $\text{ft}^3$ ) - The total volume of the enclosed space into which gas would be released.